MINERAL RESOURCES BRANCH

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ED. D. R. MACDONALD

THE WESTIN NOVA SCOTIAN HOTEL
NOVEMBER 1 AND 2, 2004

NOVA SCOTIA
Natural Resources

Honourable Richard Hurlburt
Minister

Peter Underwood
Deputy Minister

Halifax, Nova Scotia
2004

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Program

Commonwealth Ballroom A and B, The Westin Nova Scotian Hotel, Halifax

Monday, November 1, 2004

8:30 am - 7:00 pm	**Registration (Commonwealth Foyer)**
8:30 am - 9:00 am	**Coffee and Refreshments (Commonwealth B)**
10:00 am - 9:00 pm	**Displays Open (Commonwealth A)**

Note: All talks will be presented in Commonwealth B

Session 1. *Current Developments in Nova Scotia's Mining Industry*

Session Chair: Scott Swinden, Nova Scotia Department of Natural Resources (DNR)

9:00 am - 9:10 am
Peter Underwood, Deputy Minister, DNR: ***Welcoming Remarks***
9:10 am - 9:40 am
Mike MacDonald, DNR: ***Mining and Mineral Exploration in Nova Scotia***
9:40 am - 10:00 am
Mike Cherry, DNR: ***Overview of Activities of the Geological Services Division***
10:00 am - 10:10 am
Scott Swinden, DNR: ***A Mineral Development Strategy for Nova Scotia***
10:10 am - 10:40 pm
Refreshment Break
10:40 am - 10:50 am
Paul Boutilier, Nova Scotia Business Inc.: ***Nova Scotia Business Inc. and the Mineral Industry***
10:50 am - 11:10 am
Rhyne Simpson Jr., Federal Gypsum Company: ***The Point Tupper Gypsum Wallboard Plant: Project Update***
11:10 am - 11:30 am
Debra Donovan and Rod Simpson, Scotia Slate Products Ltd.: ***Nature to be Commanded, Must be Obeyed***
11:30 am - 11:50 pm
Peter Oram, MGI Limited: ***Mine Permitting 101: How to Get a Mine Permitted in Nova Scotia***
12:00 pm - 2:00 pm
Mining Society of Nova Scotia Luncheon, Atlantic Ballroom. Keynote Speaker - Ron Hawkes, Diamond Ventures Ltd.: ***Why We Explore for Gold: the Success of Plutonic Resources Limited in Australia,*** **Cost $20**

Session 2. *East Kemptville 25 Years Later: the Mineral Wealth of Southwestern Nova Scotia*

Session Chair: Mike Cherry, DNR

2:00 pm - 2:05 pm
Mike Cherry, DNR: ***Introductory Comments***
2:05 pm - 2:25 pm
Chris White, DNR: ***The Last 550 Million Years - a Geological History of Southwestern Nova Scotia***
2:25 pm - 2:40 pm
Dan Kontak, DNR: ***25th Anniversary of the Discovery of the East Kemptville Tin Deposit...Where to Now?***
2:40 pm - 3:00 pm
Representative of BHP Billiton: ***Reclaiming the East Kemptville Tin Mine***
3.00 pm - 3.20 pm
Mike MacDonald, DNR, and Guy MacGillivray, W. G. Shaw and Associates: ***Serendipity: A Case Study of Mineral Exploration in Southwestern Nova Scotia***
3:20 pm - 3:40 pm
Don Hilton, Black Bull Resources: ***The White Rock Mine, Southwestern Nova Scotia***
3:40 pm - 4:00 pm
Refreshment Break

4:00 pm - 4:20 pm
A. R. (Sandy) Anderson, DNR: ***Peat Resources of Southwestern Nova Scotia***
4:20 pm - 4:40 pm
Dan Kontak, DNR: ***An Update on Industrial Mineral Projects in Southwestern Nova Scotia: Kitty Litter to Make-up***
4:40 pm - 5:00 pm
Rick Horne, George O'Reilly, Dan Kontak, Chris White and Mike Corey, DNR: ***Shear Zones and Mineralization in Southwestern Nova Scotia***
5:00 pm
Beer and Beef-on-a-bun Reception Hosted by the Hon. Richard Hurlburt, Minister of Natural Resources, with Guest Speaker the Hon. Ernest Fage, Minister of Economic Development, Commonwealth Ballroom A, Cost $10

Tuesday, November 2, 2004

8:30 am - 12:30 pm	**Registration**
8:30 am - 3:00 pm	**Displays Open (Commonwealth A)**
8:30 am - 9:00 am	**Coffee and Refreshments**

Session 3. *Rocks to Riches: Geology and Mineral Wealth of the Carboniferous in Nova Scotia*

Session Chair: Mike Cherry

9:00 am - 9:20 am
Peter Giles, Natural Resources Canada: ***Recent Advances in the Geology of the Windsor Group in Nova Scotia***
9:20 am - 9:40 am
Dave Carter, Hy-Grade Geoscience: ***LNG, CNG and Salt Cavern Storage***
9:40 am - 10:00 am
Phil Finck, DNR: ***Nova Scotia's Gypsum Industry: Past, Present and Future***
10:00 am - 10:40 am
Refreshment Break
10:40 am - 11:00 am
Tom Martel, Corridor Resources Inc.: ***The Depositional Sequence of the Horton Group and its Significance for Hydrocarbon Exploration***
11:00 am - 11:20 am
John Calder, DNR: ***Geology and Economic Potential of Upper Carboniferous Rocks in Nova Scotia: Tradition Meets Innovation***
11:20 am - 11:40 am
Bob Ryan, DNR: ***Basin Brine Expulsion, Solution Front, to IOCG Models - The Carboniferous Cu-Ag-Au-Co-Pb-Zn Connection***
11:40 am - 12:00 pm
Scott Swinden, DNR: ***Concluding Remarks***
12:15 pm - 1:30 pm

Geoscience Luncheon, Atlantic Ballroom. Keynote Speaker - Gordon Fader, Natural Resources Canada: ***The Story of Halifax Harbour,*** **Cost $20**
12:00 pm - 3:00 pm
Cash Bar, Commonwealth Ballroom A
3:00 pm
Conference Closed

Post-conference Field Trips (Wednesday, November 3, 2004)

The Black Bull Resources White Rock Mine and Other Mineral Resources of Southwestern Nova Scotia, **field trip leaders Dan Kontak, Mike MacDonald and Phil Finck, DNR, Cost $10**

Metro-Geo: Urban Geology of the Halifax Area, **field trip leaders Fred Bonner and Howard Donohoe, DNR, Cost $10**

Peat Resources of Southwestern Nova Scotia

A. R. Anderson

In 1979 the Nova Scotia Department of Mines and Energy began an assessment program that would delineate the province's peat resources and determine whether sufficient fuel-grade peat existed to warrant development.

The program identified that almost one-third of the province's peatlands reside in the three southwestern counties of the province (54 000 ha - Yarmouth, Shelburne and Queens). Subsequent field investigations evaluated 100 bogs (4 700 ha) in the region. While peat depths could reach over 8 m, average depth was calculated to be 2.4-2.6 m. Peat was primarily *Sphagnum* based, and generally the first metre of the profile consisted of poorly humified peat (moss) and the lower portions were moderately to well humified peat (fuel). Whereas a number of the deposits throughout the region were predominantly fuel-grade peat, most had significant accumulations of overlying moss-grade peat.

During the inventory program, an engineering study was carried out to determine whether conditions conducive to developing a fuel-peat harvesting operation existed. As well, research was done to compare the region's climatic conditions to existing peat-harvesting regions.

The Callie Lode Gold Deposit, Northern Territory, Australia: High-grade, Sheeted, Auriferous Quartz Veins in an Anticlinal Structural Environment

J. Bigelow[1] *and C. R. Stanley*[1]

The Callie lode gold deposit, located in the Tanami desert at Dead Bullock Soak, Northern Territory, Australia, is hosted by fine-grained, carbonaceous, clastic meta-sedimentary rocks of Paleo-Proterozoic age that have been folded into a complex anticline. Mineralization consists of coarse native gold within 1 to 2 cm thick sheeted quartz ± chlorite veins that can be related to folding of the sedimentary sequence. Sericite and chlorite may represent associated hydrothermal alteration products, but do not generally exhibit any spatial relationship with mineralization or veining. Gold-bearing veins occur within bleached (de-carbonized) zones in the productive politic host stratigraphy (Lower Blake Beds, Callie Laminated Beds, Magpie Schist). The deposit is mined from underground workings developed from the bottom of the initial open pit.

Gold mineralization exhibits a very large nugget effect, which creates significant challenges for reserve estimation. Visible gold commonly occurs at the intersections of veins with the basal, coarse-grained portions of distal turbidite beds, suggesting an important precipitation control. Historic explanations for gold precipitation have involved redox reactions between oxidizing, auriferous fluids and carbonaceous sediments to precipitate gold. This model does not explain the relationship between gold shoots within the veins and the basal portions of turbidite beds. Detailed investigation of the higher-grade portions of these veins reveals that an alternative precipitation mechanism is required. The strong relationship between the higher-grade portions of veins and turbidite beds suggests a metasomatically driven precipitation control involving chemical reactions between auriferous fluids and minerals in the coarser turbidite bases.

The similarities and differences between the Callie deposit and saddle reef gold deposits in Nova Scotia and Victoria, Australia, provide important insights into critical factors that control the genesis of these deposits.

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Geology and Economic Potential of Upper Carboniferous Rocks in Nova Scotia: Tradition Meets Innovation

J. H. Calder

The Carboniferous rocks of Nova Scotia have long been celebrated as some of the world's best exposures of their age, and have been equally important as the economic backbone of the mineral industry in the province. In the face of changing economic conditions, particularly the closure of underground coal mining operations in the Sydney Basin, new directions for geoscience research are required. Looming in the background, however, the world political theatre and the arrival of peak oil, where production will increasingly lose ground to consumption, cannot be underestimated as drivers for future resource development, particularly in the energy sector. The first to see a rebirth will be the coal industry. A challenge for political planners will be to maintain the knowledge base of government surveys in the interim so that they will be in a position to act when 'the writ comes down'.

Traditional industrial mineral and energy resources that continue to be important include dimension stone, aggregate, and coal from surface operations. Interest continues as well in metallic deposits, including stratabound Cu-Ag-Au, Pb-Zn, and Carboniferous iron oxide-copper-gold deposits of the Cobequid-Chedabucto Fault Zone. Bridging the traditional and new is exploration for coalbed methane and conventional petroleum that demands innovative models for Upper Carboniferous rocks in particular. A huge information resource that will continue to be tapped for years to come is the recently acquired high resolution seismic data over much of the Carboniferous, a windfall of the petroleum exploration that attended the construction of the Maritimes and Northeast pipeline. Non-traditional needs will be imposed, an indication of which is the investigation of CO_2 sequestration potential. Pressures on groundwater resources are a given worldwide, and Nova Scotia will be no exception. Such new demands will require, most of all, sound geological knowledge, the foundation of which is mapping and stratigraphic studies, coupled with predictive modelling from deposit-scale studies.

In the meantime, new research into sections long studied is increasing our ability to 'read the rocks' and to make informed judgments of traditional and new resource potential. Innovation is not restricted to the geoscientist, however. A compelling if modest example of new and old approaches moving forward side by side is the revitalization of the stoneworks at Wallace. Here, quarrying of Boss Point sandstone is seeing a rebirth, not only for its traditional use as a building stone, but as a medium for artistic sculpture: both celebrate these rocks and their use as our heritage. At Joggins, a similar parallel in innovation is unfolding. Current research by a working group of colleagues from the Nova Scotia Department of Natural Resources, University of Bristol, and Dalhousie University has enhanced our knowledge of the coal-bearing Carboniferous section in what may be the most significant advance since the work of Dawson and Lyell. This work supports the bid for World Heritage status being actively pursued by the community and province. In 2004 Joggins reached the watershed of official standing on Canada's Tentative List of sites to be nominated to the United Nations. Here too, the community has embraced its rich geological and mining heritage, which may mark a turning point in Nova Scotians' perception of their geological heritage.

A Comparison of the Late Triassic Dinosaur Footprints *Atreipus acadianus* and *Grallator* (*Grallator*) sp. from the Upper Wolfville Formation at North Medford, Nova Scotia[1]

B. Cameron[2] and N. Wood [2]

Along the extensive coastal exposures of the western Minas Basin of the eastern Bay of Fundy, the Late Triassic upper Wolfville Formation yields an assemblage of rare dinosaur footprints and other vertebrate and invertebrate trace fossils. These ichnites occur in a one-metre zone 5.8 m below the contact between the Wolfville Formation and the overlying Blomidon Formation. This outcrop exposes part of a fluvial sequence near the base of a very narrow promontory that is being rapidly eroded away on three sides. The vertebrate footprint assemblage is represented in our collections mostly by isolated footprints on over 100 small pieces of sandstone eroded free of the outcrop by waves, tidal action and storms. The majority of the traces are dinosaur footprints.

This unique assemblage was discovered by Donald Baird in 1975 and has only been partially studied and described. One new species of dinosaur footprints, *Atreipus acadianus*, was recognized and named by Paul Olsen and Donald Baird in 1986, but, until now, this was the only dinosaur ichnospecies identified at this locality. Last summer, however, we discovered a second dinosaur footprint species that we assign to *Grallator* (*Grallator*) sp. Previously, this bipedal ichnospecies was probably overlooked because it is similar in size and general shape to the pes footprints of the quadrupedal dinosaur ichnospecies *Atreipus acadianus*.

Atreipus acadianus, which appears to have both saurischian and ornithischian features, and *Grallator* (*Grallator*) sp. both exhibit pes prints that are relatively small (9.3 to 10.7 cm lengths and 5.6 to 6.3 cm widths), typically three-toed, and have a theropod coelurosaur-like shape. However, *Atreipus acadianus* has a more slender 4th digit and is associated with a hoof-like, four-toed ornithischian-like manus 1.5 to 4 cm long. The 2nd and 4th digits of the newly recognized dinosaur footprint, referred to here as *Grallator* (*Grallator*) sp., are about equally robust and not associated with manus prints. These dinosaurs represent a third of the vertebrate ichnotaxa preserved in the assemblage. From our best trackway made by a small *Atreipus acadianus*, we estimate a running speed between 7.7 km/h and 10.1 km/h, using the equations of R. McNeill Alexander and footprint length, stride, relative stride length, estimated leg lengths and dimensionless speed.

The late Carnian or early Norian age of this ichnofaunule places this assemblage soon after the time of origin of the dinosaurs. These two dinosaur ichnospecies, *Atreipus acadianus* and *Grallator* (*Grallator*) sp., not being represented by osteological remains, are important to understanding the paleoecology and paleoenvironments of the evolving early dinosaurs in Nova Scotia. They are probably also the oldest known dinosaur footprints in Canada.

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[1]Funded in part by Acadia University, Wolfville, NS
[2]Department of Geology, Acadia University, Wolfville, NS B4P 2R6

A Geological and Geophysical Study of the Large, Positive Magnetic Anomaly between Eastern Prince Edward Island and Western Cape Breton Island, Nova Scotia

L. Cook[1], S. M. Barr[1] and S. Dehler[2]

A large, positive magnetic anomaly, with amplitudes on the order of several hundred nT, occurs in the offshore and onshore areas of eastern Prince Edward Island and southwestern Cape Breton Island. The magnetic anomaly obscures normal Appalachian geological terrane signatures in a critical area for interpreting terrane correlations between Cape Breton Island and mainland Nova Scotia and New Brunswick. Hence, the presence of the large magnetic anomaly contributes to the ambiguities in terrane boundary interpretations in this area. The onshore part of the magnetic anomaly in Cape Breton Island coincides with a positive Bouguer gravity anomaly that does not appear to extend westward, although gravity data coverage is poor in the offshore domain. High-susceptibility and low-density intrusive rocks are a possible source of the magnetic anomaly, the exact origin of which is the topic of this investigation.

The source of the potential field anomalies will be evaluated by forward modelling, using constraints from seismic, magnetic susceptibility and density data, to establish depth and orientation of the anomaly source. The first phase of the study involves measurement and analysis of magnetic susceptibility and density data. Magnetic susceptibility data have been measured for samples from the Mabou Highlands that are archived at Acadia University, as well as from outcrops in eastern Prince Edward Island and western Cape Breton Island during field work in the summer of 2004. Density data are currently being measured on these samples. Preliminary results of the magnetic susceptibility data indicate that the highest magnetic susceptibility values are from the Port Ban Diorite, the Sight Point Group, and Sight Point Injection Gneiss, compared with the relatively low values from the Mabou Highlands Leucotonalite, MacDonald Glen Brook Formation, Pictou Group, Horton Group, Mabou Group, and Windsor Group samples. The data indicate that exposed dioritic and related rocks in the Mabou Highlands, the onshore area adjacent to the magnetic anomaly, may be the source of the magnetic anomaly, but the gravity anomaly is more enigmatic. Once a possible cause for the anomaly has been modelled, it is anticipated that the location of terrane boundaries in the area can be clarified.

[1]Department of Geology, Acadia University, Wolfville, NS B4P 2R6
[2]Geological Survey of Canada, Bedford Institute of Oceanography, Dartmouth, NS B2Y 4A2

The Story of Halifax Harbour

G. B. J. Fader[1]

The Geological Survey of Canada has been involved in a study of Halifax Harbour for approximately 15 years. The research was driven by a shift in emphasis from studies in the offshore to the coastal zone, and a requirement for geoscience knowledge for the siting, design and construction of wastewater treatment facilities. This remains one of the most significant regional environmental problems. A geological framework has been developed that can be used for planning and construction of activities and engineering projects such as docking facilities, pipeline and communication cable routing, infilling and dredging.

Numerous surveys have been conducted with a variety of seismic reflection, sidescan sonar and sampling equipment. Multibeam bathymetric sonar mapping surveys have provided an unprecedented portrayal and understanding of materials and geological processes. We now have a much better understanding of how the harbour works in terms of sediment deposition and erosion. The anthropogenic or human imprint on the seabed of the inner harbour is widespread, difficult to interpret, and has profoundly affected the natural geological processes of sedimentation and erosion.

The floor of the outer harbour consists of coarse, well-sorted sand and gravel, with bedrock outcrop in shoal areas. In striking contrast, the inner harbour is largely floored by Holocene mud, which is gas-charged in places and covered with anchor marks, dredge spoils and other debris. Natural features such as sedimentary furrows, drumlins, moraines, pockmarks and former shorelines are widespread. The harbour traps sediments with their associated contaminants within the inner part, and only minimal quantities are transported beyond the outer harbour. Periodic strong currents, driven by large storms, affect both the outer and inner areas of the harbour with the remobilization of sediments and development of a variety of bedforms. Seabed scour by propellers and sediment reworking by anchoring are processes that disturb, mix and remobilize the fine-grained sediments in the inner harbour.

The presentation will highlight some of the more unusual attributes of Halifax Harbour including: approximately 100 shipwrecks; gas-escape craters termed pockmarks; former lake shorelines and islands of Bedford Basin; effects of the Halifax Explosion of 1917, and the discovery of the original bridges that crossed The Narrows. A preliminary assessment of the effects of Hurricane Juan on the seabed of Halifax Harbour indicates significant but local change, particularly in the outer harbour and the Northwest Arm.

[1]Natural Resources Canada, Geological Survey of Canada (Atlantic), Bedford Institute of Oceanography, Box 1006, Dartmouth, NS B2Y 4A2

Recent Advances in the Geology of the Windsor Group in Nova Scotia

P. S. Giles[1]

The Carboniferous Windsor Group, characterized by marine deposition, is both an historic and continuing contributor to Nova Scotia's mineral economy. Since its initial documentation in the type area circa 1930, much has been learned about the group, beginning largely with newly available subsurface data coupled with regional mapping in the late 1970s (Shubenacadie and Musquodoboit basins; >150 000 m diamond-drill core logged) and continuing today. In southern Nova Scotia, in northern Nova Scotia east of the Stellarton-New Glasgow area, and throughout Cape Breton Island, all marine strata of the group are represented and characterized by abundant evaporites associated with approximately thirty discrete marine bands marked by limestone deposition. In the middle and upper parts of the group in these areas, lateral continuity of marine marker beds is excellent and provides a fundamental tool for stratigraphic correlation within the group. Detailed stratigraphic correlation using subsurface data has permitted the documentation of dramatic local structural complexity, seldom indicated by limited exposure of these strata. Very large-scale structural discontinuities have been documented where lower evaporites have provided translation surfaces for gravity-driven down-to-the-basin movement, resulting in very large gaps in the stratigraphic record in some areas. In northwestern Nova Scotia, the middle Windsor Group marine bands are sparsely represented and upper Windsor marine bands unknown. Marine limestones and evaporites seen elsewhere in Nova Scotia, seem largely represented by subaerial redbeds in this part of Nova Scotia and in New Brunswick. The lower Windsor Group, however, is consistent in lithologic character throughout the Maritimes Basin, albeit with complex facies relationships in basin-margin areas.

In addition to enhanced understanding of regional stratigraphy and structure in the last thirty years, advances have also been made in other areas of study. The Macumber limestone for example, which marks the first short-lived marine deposit of the group, served as a text-book example for shallow-water strand-line carbonate deposition in the 1960s, but more recently is interpreted as a relatively deep water limestone. Key to this interpretation is the recognition that biohermal limestones of the Gays River Formation pass downslope to the Macumber facies. Middle and upper Windsor Group evaporites, which have been interpreted as marginal marine sabkha deposits, are presently considered to be largely subaqueous marine deposits representing evaporitic poisoning of the depositional regime during regression. The most recent biostratigraphic work suggests that a significant hiatus (~4 million years) separates the lower (Late Arundian) and middle (Late Asbian) Windsor Group, and that the youngest Windsor strata are of latest Viséan age, deposited virtually at the Viséan-Namurian boundary. The pronounced rhythmic character of the middle and upper Windsor Group has most recently been attributed to orbitally forced sea-level change linked to late Viséan initiation of Gondwanan Carboniferous glaciation. This work has revealed that the "marine environment", which has traditionally characterized the Windsor Group in eastern Canada, was only episodically established in the Maritimes Basin and perhaps for as little as 5% of middle to Late Viséan time. Although the marine rocks of the group have appropriately received attention due to their economic importance and stratigraphic utility, a significant challenge remains in understanding the non-marine facets of late Viséan deposition on a regional basis. Thirty years of collective and collaborative work has resulted in a better-documented lithostratigraphic framework, coupled with more secure understanding of time-stratigraphic constraints, and will hopefully be useful to a new generation of Windsor Group researchers.

[1]Natural Resources Canada, Geological Survey of Canada (Atlantic), PO Box 1006, Dartmouth, NS B2Y 4A2

Update on the Bedrock Mapping Component of the Targeted Geoscience Initiative (Phase 2)

P. S Giles[1], R. D. Naylor and D. C. Brisco

The Geological Survey of Canada (GSC) and the Nova Scotia Department of Natural Resources are in the final year of a two-year project that forms part of the second phase of a national Targeted Geoscience Initiative (TGI-2). An important component of the Nova Scotia work is to create new 1:50 000 scale digital maps of NTS areas 11E/06 and 11E/07. The new maps will include digitized data from previously published maps, unpublished data from mapping undertaken from 1970 to 1995, and new bedrock mapping. All new and historical data have been compiled into ArcView® format.

During the last two field seasons strategic bedrock mapping and palynological sampling have been conducted over much of the map area. Mapping in the southern portions of NTS areas 11E/06 and 11E/07, where Horton Group strata dominate, has helped link TGI-2 mapping to existing maps to the south and west, and to resolve map-boundary issues. Mapping on NTS area 11E/06 is of critical importance in relating the geology of the St. Marys Basin to strata of similar early Carboniferous age and lithologic character in the Horton-Windsor group type areas. Mapping in the northern area of 11E/06 and 11E/07 has focused on defining stratigraphic boundaries within the Late Carboniferous and resolving map-boundary relationships with David and Georgia Piper's soon to be released 1:50 000 scale maps of the Cobequid Highlands. In addition to the 1:50 000 scale maps a series of thirteen detailed 1:10 000 scale maps are being prepared that cover most of the northern area of 11E/06.

Recent high quality seismic data and reprocessed airborne geophysical data have been used to assist with creation of the 1:10 000 and 1:50 000 sheets. The seismic data have been particularly useful in defining unit thickness and the general character of major faults. Aeromagnetic data have helped define both stratigraphic and structural boundaries. The reprocessed geophysical data will be released as a series of 130 maps that cover most of northern and central Nova Scotia.

All map-based products generated by TGI-2 are scheduled for completion by April 2005.

[1]Natural Resources Canada, Geological Survey of Canada (Atlantic), PO Box 1006, Dartmouth, NS B2Y 4A2

Nova Scotia Gold Grain Study: Background Concentrations and Distance of Transport

T. A. Goodwin

During the 2004 field season, 10 kg till samples were collected in order to determine background concentrations of gold grains from across the province, and to determine the morphology of each of the grains recovered.

Regional till sampling programs from deposits throughout most of Canada have been routinely undertaken by various levels of government and, of course, mineral exploration companies in their search for gold. As a result of these programs, background concentrations of gold grains in the heavy mineral concentrate (HMC) from 10 kg till samples are known for many gold terranes. For example, background concentrations of gold grains in till from across the Abitibi Greenstone Belt range from <1 gold grain in the north to 10 gold grains in the south. Similarly, surface features and textures observed on kimberlite indicator minerals (KIMs) recovered from the HMC of till samples provide clues to the distance of transport. For example, the presence of kelyphite rims on pyrope grains provides some indication of the relative distance of transport, as does the presence of orange peel texture.

As part of the regional till sampling programs, the morphology of gold grains recovered from till samples is generally described by three categories: pristine, modified and reshaped. The distance of glacial transport from source can be estimated based on gold grain morphology: pristine grains are indicative of minimal transport ranging from 0 to 100 m, modified gold grains have travelled in the order of 500 m, and reshaped grains in excess of 1000 m. There are, of course, exceptions.

Data on gold grain morphology and background concentrations of gold grains in till are currently unavailable for Nova Scotia. Studies involving electron microprobe analysis, used to determine the composition of individual gold grains, have been completed on numerous Nova Scotia gold districts.

Twenty till samples were collected during the 2004 field season. Fourteen of the samples were collected regionally from throughout the mainland, with the majority of the samples being collected from the Meguma Terrane. Samples were collected from roadside till exposures in an effort to characterize regional background gold grain concentrations and gold grain morphologies. Six samples were collected from within a past-producing gold district in order to determine anomalous gold grain concentrations and to determine gold grain morphologies associated with known deposits.

All samples collected during the 2004 field season have been sent to Overburden Drilling Management (ODM) Limited of Nepean, Ontario. ODM will process the 10 kg till samples, recover and classify the gold grains based on their morphology, and produce a HMC. A 30 g sample of the <63 microns size fraction will be sent for gold (+ 51 element ICP-MS) analysis for comparison of the geochemical signature with the gold grains recovered.

Regional and Detailed Geochemical Sampling of Humus, Soil and Till in the Upper and Lower Seal Harbour Gold Districts

T. A. Goodwin

The Metals in the Environment (MITE) Program is a multidisciplinary project initiated by the Geological Survey of Canada (GSC) to examine metals and metalloids in the environments associated with past-producing gold districts throughout Nova Scotia. There are three main objectives of the current MITE study:
(1) determine the concentrations, distribution and speciation of elements proximal to the mine sites,
(2) identify and characterize processes that control the release of elements from the tailings; and
(3) quantify the off-site transport of elements from mine wastes, and the transformation and fate of these elements in the receiving environments.

Most of the gold recovered between 1861 to the mid-1940s was recovered using a combination of stamp mills and mercury amalgamation. It has been estimated that up to 25% of the mercury added during the amalgamation process may have been lost to the tailings, to the air through volatilization, or to the local environment through spillage. Elevated levels of other naturally occurring toxic elements (e.g. As, Tl) may occur in the mine wastes such as the tailings or rock dumps.

As part of the larger on-going MITE research program, multi-media (humus, soil and till) geochemical sampling was completed near the Upper and Lower Seal Harbour gold districts during the 2004 field season. The program involved the collection of 22 humus, soil and till samples from a 200 km^2 area. The samples will be used to establish background concentrations for various elements, particularly As, Hg and Au in the proximity of the Upper and Lower Seal Harbour gold districts.

Sample sites were limited to roadside exposures and were selected to adequately represent the various bedrock and surficial units present in the study area. Detailed observational notes were collected at each site. The >1 cm clast fraction was washed in the field and an estimate was made of the relative proportions of metasandstone, slate, granite, quartz and 'other' clasts.

In addition to the regional multi-media sampling program, detailed sampling of B-horizon soil was completed within and near the footprint of the former Boston-Richardson Mill site located on the south-western shore of Gold Brook Lake. The B-horizon samples were collected to determine the extent of surface contamination of As and Hg (and other elements) associated with the milling of ore and the subsequent recovery of gold utilizing mercury amalgamation.

All samples collected during the 2004 field season will be sent for 52 element ICP-MS analysis for both the <63 and <2000 microns size fractions.

Regional Humus, Soil and Till Sampling for the Targeted Geoscience Initiative (Phase 2)

T. A. Goodwin

The Geological Survey of Canada (GSC) and the Nova Scotia Department of Natural Resources (NSDNR) are in the second year of a two-year project with the main objective to improve understanding of the hydrocarbon and mineral resources in the area of NTS map sheets 11E/06 and 11F/07. The work forms part of the second phase of the Targeted Geoscience Initiative (TGI-2). In addition to GSC and NSDNR staff, this collaborative project will include researchers from various Canadian universities, other government organizations and private industry.

Currently, there is a strong exploration interest in iron oxide-copper-gold (IOCG) mineralization near the Cobequid-Chedibucto Fault Zone (CCFZ). Regional geochemical sampling of humus, soil and till specific to IOCG style mineralization does not exist in the TGI-2 study area. Humus and soil have never been collected during any provincial geochemical survey, although limited humus and soil data are available in the assessment files. Regional NSDNR till geochemical data of various vintages are available, as are stream sediment/water data, but not all elements of current interest were initially analyzed by the department.

At the deposit scale (e.g. Mt. Thom: an IOCG analogue), soil and till are effective sample media based on a review of assessment report data. Stream sediment is also an effective sample medium in this environment.

During the 2004 field season, a total of 62 sites were visited and one sample each of humus, soil and till were collected from each site. Samples were collected from roadside (till) exposures or small quarry exposures. Sampling sites were restricted to four transects: (1) a north-south transect along Highway 104 near the toll booth, (2) a north-south transect across map area 11E/06, (3) a north-south transect across map area 11E/07 and (4) a north-south transect across map area 11E/08. Sample sites were selected on the basis of their bedrock and surficial geology as well as their proximity to known/inferred structures of the CCFZ. Strict quality assurance/quality control protocols were used during the sample collection stage and for subsequent sample preparation and analysis.

It is anticipated that geochemical results will characterize the regional geochemical signature of the CCFZ (which is currently unknown) as well as regional background concentrations for a number of elements in various sample media.

All samples collected during the 2004 field season have been sieved to two size fractions: <63 microns and <2000 microns. Results for both size fractions for Au + 51 elements (ICP-MS) are pending.

Geology of Mount Uniacke, NTS Map Area 11D/13

R. J. Horne, R. J. Ryan, D. Fox and M. C. Corey

A map (1:50 000 scale) of the Meguma Group for NTS map area 11D/13 (Mount Uniacke) is currently being prepared.

Stratigraphy of the Meguma Group

Goldenville Formation: The Goldenville Formation is the lower formation of the Meguma Group, and consists of metasandstone with lesser, and variable, metasiltstone and slate. Stratigraphy is mainly characterized by fining-up cycles of metasandstone grading into relatively thin intervals of metasiltstone-slate, although significant slate-dominated intervals locally occur (e.g. within the Mount Uniacke gold district). Although distinct stratigraphy occurs locally, characterized by sedimentary structure or lithology, a lack of marker units and complex map exposure resulting from folding makes it difficult to establish map units throughout the map area. However, well defined magnetic patterns, which appear to reflect stratigraphy, may be a useful substitute for correlation purposes.

Halifax Formation: The Halifax Formation conformably overlies the Goldenville Formation and includes three distinct map units: the lower Beaverbank member, the middle Cunard member, and the upper Glen Brook member. The Beaverbank member is characterized by grey metasiltstone, thin metasandstone beds, slate and, locally, intervals containing thin (<1-3 cm) coticule layers. The Cunard member is characterized by finely laminated black slate with thinly bedded metasiltstone/metasandstone layers, commonly with high concentrations of pyrite and pyrrhotite. The Glen Brook member consists of distinct, colour-banded, green-grey, laminated metasiltstone with minor slate and local medium-bedded metasandstone.

Structure

The Meguma Group is folded into a regional-scale anticlinorium, exposing the Goldenville Formation, and synclinorium, exposing the Halifax Formation, and smaller, second-order folds. A spaced pressure-solution cleavage in metasandstone and fine continuous cleavage in slate is axial planar to regional folds. A crenulation cleavage is locally developed within the Halifax Formation, interpreted to reflect fold-related, bedding-parallel shear. Northwest-trending brittle faults postdate Devonian granites and display sinistral strike-slip separation. A high strain zone locally occurring within the contact aureole (cordierite±adalusite±sillimenite hornfels) of the South Mountain Batholith is characterized by a schistose foliation and steep mineral (stretching) lineation which reflects intrusion-related strain.

Economic Geology

Several past-producing gold districts, consisting of mesothermal quartz veins, occur in the map area. In addition, a series of previously undescribed, closely spaced, bedding-parallel veins, which resemble those within the gold districts, are exposed on a logging road north of Lakelands. Some of the veins contain arsenopyrite and geochemistry indicates locally elevated concentration of As, Cu, Pb, Zn and Au. Disseminated gold-lead mineralization was discovered in the North Beaverbank area during this mapping program and placer gold was reportedly recovered from the Herbert River. Sphalerite was noted in a calcite vein north of the airport and several barite veins were observed cutting the Kinsac Pluton. Local high concentrations of andalusite within the contact aureole of the South Mountain Batholith may be of economic value and the Goldenville Formation hosts several aggregate quarries.

Overview of Exploration, Discovery and Geological Studies of the East Kemptville Sn-Zn-Cu-Ag Deposit, Yarmouth County, Nova Scotia

D. J. Kontak

In the fall of 1985, the East Kemptville tin deposit went into production, some six years after first being drilled, and became the first and only primary producer of tin in North America. The discovery and development of this deposit represented the culminating efforts of a regional geochemical exploration program initially started due to discovery in the fall of 1975 by Cuvier Mines Ltd. of richly mineralized (Cu-Pb-Zn-Sn-W) Meguma Group boulders in glacial aggregate deposits in the Plymouth area of southwest Nova Scotia. After local mining promoter Mr. A. Hudgins interested Shell Canada Ltd. in 1976 to explore the area, a regional geophysical and geochemical till sampling program was conducted in the spring and summer of 1977. After failure to discover a lode source for the richly mineralized boulder samples, a much larger regional program was implemented in the spring of 1978 over southwest Nova Scotia from Bridgewater-Caledonia westwards. The collection and processing of several thousand till samples was highlighted by five highly anomalous samples (wt. % Sn levels in concentrates) from the East Kemptville area by June 1978. Subsequent boulder and bedrock mapping of the surrounding area lead to the mineralized zone at the site of what would become the East Kemptville deposit. The ensuing drilling program commenced in 1979 with the first hole intersecting an ore-grade width of tin mineralization. This discovery remains an excellent example of applying broad geological reasoning and excellent exploration principles.

Regional and deposit scale studies since the late 1970s provide a framework in which to now interpret the East Kemptville deposit. The deposit is hosted by an evolved topaz-muscovite leucogranite (lcgr), the end product of extreme crystal ± fluid fractionation of the F-rich peraluminous Davis Lake Pluton. The host leucogranite is fine-grained to aphanitic at its contact with Meguma Group metasandstones, but coarsens inwards and downwards. The presence of crenulate layers and miarolitic cavities along the upper contact of the leucogranite reflect cycling of fluid pressure in a volatile-rich magma chamber. Mineralization occurs in structurally controlled, sheeted topaz-rich cassiterite-sulphide greisens in the Main Zone, but within a massive, 100 m thick topaz greisen in the Baby Zone; later sulphide-rich quartz veins in the deposit are kinematically related to the greisens. Isotopic and fluid inclusion studies indicate the mineral deposit formed ca. 375 Ma from a magmatic fluid at 3.5 kbar pressure. Petrological studies suggest that the two ore zones are underlain by two distinct granites, an important aspect for future exploration.

The East Kemptville deposit is only one of many mineralized sites in the southwestern Nova Scotia tin domain. Prospective ground for additional deposits is considered to underlie most of the area west of the present deposit, thus offering opportunity for further tin and base metal mining in the area. Interestingly, the source of the richly mineralized boulders that sparked the discovery of the East Kemptville deposit remains unknown.

From Kitty Litter to Make-up: Geological Setting and Potential of Industrial Mineral Commodities in Southwestern Nova Scotia

D. J. Kontak

The diverse geology of southwestern Nova Scotia, combined with easy access and proximity to deep-water transportation, offers potential for a wide variety of industrial minerals, such as silica, garnet, topaz, feldspar, mica, zeolite, and aggregate, to name a few. In this presentation the geological setting of the North Mountain Basalt (NMB), a source of both high-quality aggregate and zeolites, and the Brazil Lake pegmatite (BLP), source of industrial grade spodumene, silica, mica and feldspar, are discussed. There is considerable potential in both these environments for production of industrial mineral material.

The Jurassic (201 Ma) North Mountain Basalt outcrops continuously along the south side of the Bay of Fundy. It is composed of three distinct units, the lower, middle and upper flow units (LFU, MFU, UFU). The LFU (≤185 m) and UFU (≤150 m) represent single flows and are generally massive, columnar jointed and quite fresh, which make them suitable as aggregate resource material. Existing aggregate operations are mainly in the LFU and vary from moderate (e.g. Parker Mountain) to small (e.g. Glenmont, Viewmount) operations, but some excavation occurs in the UFU (e.g. Freeport, Tiverton). The favourable proximity of the UFU to deep-water access makes this unit more suitable for large commercial aggregate operations. In contrast to the LFU and UFU, the MFU is not suitable for high-quality aggregate production due to the presence of abundant zeolite minerals and low strength. The MFU consists of multiple (≤15-20), thin (≤12-15 m) flows with a zoned, classic vesicle distribution with subsequent occlution by zeolites. The uppermost zone of 1-3 m may contain 30-50% zeolites with the remaining flow containing zeolites in amygdules and also replacing the host basalt. With its geographic location and proximity to water, the MFU is considered an important zeolite resource.

The Brazil Lake pegmatite is hosted by metasedimentary and metavolcanic rocks of the Silurian (440 Ma) White Rock Formation and occurs ca. 15 km west of the chemically evolved, peraluminous 380 Ma Davis Lake Pluton (DLP), part of the South Mountain Batholith. The U/Pb tantalite age of 395 ± 1 Ma for the BLP corresponds to a period of magmatic quiescence in this area and suggests an amagmatic origin. Mapping of one of pegmatite dykes revealed the following: (1) heterogeneous nucleation of coarse (1-2 m) Kfs and Spd megacrysts oriented perpendicular to the contact; (2) intergranular Qtz-Kfs-Ab-Ms-Spd between the coarse Kfs and Spd; (3) a locally developed wall zone of fine-grained pegmatite with quartz enrichment; (4) structural control on pegmatite emplacement. Secondary mineral growth is recorded by: (1) abundant exomorphic Tur in the wallrock; (2) silicification of the wall rock; (3) Alb replacing primary pegmatitic Kfs ($Or_{75}Ab_{25}$; K/Rb=20, K/Cs=450-1000); and (4) abundant Ms (Rb=<5000 ppm, Li=330-1500 ppm) pods after Kfs. Accessory minerals, many secondary and in Alb-rich rock, include apatite, garnet, triplite, beryl, topaz, Ta-Nb oxides, cassiterite, biotite, titanite, lithiophillite, fillowite, and amblygonite/montebrasite. The coarse nature of the minerals, along with their physical and chemical properties, make most of the pegmatite amenable to industrial mineral application. Analogies with other LCT-type pegmatite fields indicates considerable potential for further discoveries of such pegmatite.

Appalachian Energy Project (TGI-2): Progress Report on Activities in Eastern Canada

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The Appalachian Energy project under the federal-provincial Targeted Geoscience Initiative (TGI-2; 2003-2005) was defined by the provincial surveys and the Geological Survey of Canada. The project aims at a better understanding of the hydrocarbon systems of the Appalachians. Over an 18 month period, the Earth Science Sector of Natural Resources Canada will invest $2.2 million in data acquisition and interpretation. Moreover, five industrial-government projects are in progress.

In Quebec, a marine seismic program (3000 linear kilometres; fall 2003 and summer 2004) was carried out in the St. Lawrence River. Acquisition from the private sector of a recent high-resolution aeromagnetic survey (HRAM; 32 000 linear kilometres) in eastern Gaspé was completed and maps released in the fall of 2004. A 52 000 linear kilometres new HRAM survey was flown in early 2004 in southern Gaspé; data will be released in spring 2005. From 2003-2004, high-resolution field gravimetric data were gathered and published for the entire Gaspé Peninsula. New source rock and maturation data were acquired in southern Gaspé.

In northern New Brunswick, a detailed hydrocarbon system analysis is being carried out in the Silurian-Devonian Gaspé Belt with organic matter maturation, source rock potential, and reservoir studies in progress. HRAM data were acquired to cover some left-over areas from the Restigouche survey and to merge with the new southern Gaspé survey. A 23 000 linear kilometres HRAM survey was flown in southern New Brunswick that covers the Carboniferous basin and its underlying basement. Data were released in the early fall. A digital synthesis of all organic matter and maturation data for the Carboniferous basin of southern New Brunswick is in progress with the first maturation maps to be released this fall.

A synthesis of the Carboniferous basin in central Nova Scotia is in progress. New 1:50 000 scale maps will be released together with a detailed litho- and biostratigraphic appraisal of this poorly known, hydrocarbon prospective basin. Hydrocarbon system data will be synthesized and published and will cover some reprocessing of recent industry seismic data.

The 1:50 000 mapping of the Cambrian-Ordovician Humber Arm Allochthon will be completed in western Newfoundland. The study includes some extensive sampling for source rock potential and maturation of this large area of western Newfoundland. Some samples from the Carboniferous basins were also studied for source rock potential.

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Mining and Mineral Exploration in Nova Scotia

M. A. MacDonald

The mining industry continues to play an important role in the economy of Nova Scotia. The value of mineral production in recent years has averaged approximately $300 million. Gypsum continues to lead the way with about 80% of the total Canadian production extracted from five surface mines. Salt production, from an underground mine and a brine operation, is approximately 1 million tonnes annually, or 10% of Canadian production. Other commodities include aggregate, barite, peat, limestone, dolomite, and dimension stone (slate, marble, sandstone, granite).

Nova Scotia has a new mine! In April 2004, Black Bull Resources Ltd. commenced development work at its White Rock Mine near Yarmouth. The company has defined a high-quality quartz (silica) deposit with total measured plus indicated resources of 12.2 million tonnes, grading 97.4% SiO_2, with an additional inferred resource of 7.3 million tonnes.

Coal mining, a mainstay of the Nova Scotia mineral industry, has undergone major change in recent years, owing principally to the closure of the Devco mines in Cape Breton. Annual coal production is currently between 0.3 and 0.4 million tonnes from five surface mines. Several recent developments represent good news for the provincial coal industry. Pioneer Coal Company has come to an agreement with Stellarton for an extension of its current coal mine. In May 2004, the provincial government announced that it had accepted proposals from three companies to explore, develop and reclaim four claim blocks in the Sydney coalfield. The Nova Scotia government is preparing a tender for the mineral rights to the Donkin resource block, the final major submarine coal deposit in the Sydney coalfield.

Mineral exploration has increased substantially in recent years, with current expenditures of approximately $5 million. Most activities are focused on precious metals, with three main targets: iron oxide-copper-gold (IOCG) along the Cobequid-Chedabucto Fault Zone; large-tonnage low-grade disseminated gold deposits (e.g. Touquoy) in turbidite rocks of the Meguma Terrane; and high-grade lode gold deposits in the Meguma Terrane. Additional exploration work has targeted carbonate, gypsum, and salt structures for underground hydrocarbon storage.

Serendipity: A Case Study of Mineral Exploration in Southwestern Nova Scotia

M. A. MacDonald and G. MacGillivray[1]

Like many regions of North America, Nova Scotia is covered by a veneer of till that conceals the underlying bedrock and associated mineral deposits. Accordingly, mineral explorationists employ a variety of techniques, including traditional boot and hammer prospecting, geological mapping, and a plethora of geophysical and geochemical methods. The discovery of many mineral deposits has had an element of serendipity, which can be defined as "the gift of finding valuable or agreeable things not sought for".

The new quartz mine near Yarmouth has had a long and colourful history of exploration and discovery, with a liberal helping of serendipity. Arguably, the story began with the discovery of mineralized, tin- and sulphide-bearing boulders in a new road near Plymouth by a local prospector, Mert Stewart, while working for Maritime Exploration Limited in 1976. The ensuing flurry of exploration involved several large multi-national companies, including Shell Canada Minerals, and ultimately led to the discovery of the East Kemptville Mine, which produced tin, copper and zinc from 1985 to 1992.

In an attempt to find more 'East Kemptvilles', Shell conducted a diamond-drilling program along the southern contact of the Davis Lake Pluton in 1981. Several holes near Flintstone Rock encountered a large zone of quartz and kaolin, representing alteration and brecciation of granite, that was deemed uneconomic and of no further interest. The common association of kaolin alteration and tin mineralization was recognized, but the potential for Cornwall-style 'China clay' deposits was not. By the mid-1980s, mineral exploration in southwestern Nova Scotia was minimal, particularly in light of low tin prices.

Ten years later the story takes a big turn. Enter Ralph Stea and Phil Finck, two geologists with the Department of Natural Resources, who conducted a regional study of Cretaceous sediments in the Shubenacadie-Musquodoboit Valley region of central Nova Scotia from 1994 to 1997. Their geological mapping led to the discovery of large buried beds of kaolin, with potential applications including the production of mineral fillers. A new company, Kaoclay Resources, was formed in 1996 to explore for economic deposits of kaolin in the Musquodoboit Valley and other Carboniferous lowland areas throughout northern Nova Scotia and Cape Breton Island. This resulted in an exploration 'boom' for sedimentary kaolin throughout the late 1990s.

In 1997, StoraEnso announced plans to construct a super-calendered paper mill in Port Hawkesbury, which would use approximately 130 000 tonnes of Cornwall-style primary kaolin annually. Kaolin was a notable commodity to many explorationists, and Guy MacGillivray was no exception. Guy formed CAG Enterprises with two of his brothers and conducted initial exploration leading to the confirmation of a large deposit of kaolin and quartz in the area of the present White Rock deposit. This caught the attention of Vancouver-based Black Bull Resources in 1998. Black Bull has defined what has been described as the largest deposit of white quartz in eastern North America. In early 2004 the company received the final permits to commence mining activities at the White Rock Mine, the culmination of a long and somewhat serendipitous journey of mineral exploration.

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The Horton Group Depositional Sequence and its Significance for Hydrocarbon Exploration

T. Martel[1]

The Horton Group strata were deposited in actively subsiding extensional basins within the larger Maritimes Basin. Continental deposits within extensional basins commonly follow a systematic three-stage pattern that relates to the changing stream gradients within the basin. The Horton Group deposits follow such a tripartite pattern.

The first stage of deposition occurs as subsidence lowers the stream gradient from an erosional system to a depositional system. Deposits are river-dominated with alluvial fans on the faulted basin edges and fluvial deposits along the basin axis.

The second stage is lacustrine- or playa-dominated (depending upon water budget) and occurs as subsidence lowers the base level until there is more accommodation space than incoming sediment (underfilled). The early and late lacustrine times contain fluvial deltaic systems that empty into the lake. These generally form the basin reservoir rocks. The middle lacustrine time is the deep lake or maximum underfilling period and can produce highly organic shales that form excellent source and seal rocks. Lake systems that are internally drained (have no outlet) capture all the incoming nutrients, creating algal blooms, and can form some of the richest source rocks in the world.

The third stage occurs as the lake is completely infilled and the basin returns to the state of an overfilled basin dominated by fluvial and overbank deposits.

Examples of the tripartite pattern of the Horton Group will be discussed together with the petroleum system of the second-stage lacustrine deposits.

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Placer Potential and Early Development of Placer Gold Deposits at Tangier, Halifax County

R. F. Mills

Tangier has some of the richest history of gold development in the province, and was also one of the most prolific, successful gold districts in the province. It is the place primarily responsible for the first great Nova Scotian gold rush, as gold was first discovered here in commercial quantity when Peter Mason, a local farmer, stopped in 1861 to water some beasts of burden in a local stream and discovered yellow metal in a local stream bed.

Placer gold deposits have been documented in this area in the past. In 1863, Copper Lake was drained completely and placer nuggets were mined on the bottom of the lake bed (Nova Scotia Department of Mines, 1865). Malcolm (1921) described the largest placer nugget ever recovered in Nova Scotia to have been found, "in the vicinity of Rush Lake". This placer nugget was described to have weighed almost two pounds.

In the summer of 2003 an excavator working on a local property exposed an adit at a till contact at the bottom of a "drumlinoid". The adit is unsupported by timber. The till consists of dry, very hard and well cemented, sandy and gravelly (Beaver River) till overlying a reddish clay-rich (Lawrencetown) till. The sinuous tunnel is approximately 53 m long, and is oriented almost east-west.

Ancient paleo-channels would have provided excellent opportunities for placer deposition, south and downstream from the high topography that is known to host gold-bearing quartz veins, following the direction of fluvial drainage. Five trenches were dug in late September 2004 to investigate paleo-channel streambed environments for placer potential. Five discreet trenches were also dug near the adit described, in an effort to investigate till horizons within those sections (Stea *et al.*, this volume). Samples from these environments are being investigated by running cubic yardages through a sluice box similar to those used in placer environments elsewhere.

Initial investigations of the trenches close to the adit are very positive, with concentrates returned that indicate anomalous gold concentrations in Beaver River Till. Paleo-channel samples have been taken but have not yet been run through the sluice. Further results should be available shortly.

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Petrology and Tectonic Setting of the Seal Island Pluton, Offshore Southwestern Nova Scotia

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The Seal Island Pluton outcrops on Seal Island as well as nearby Mud, Round, and Noddy islands, located 30 km west of Cape Sable Island off southwestern Nova Scotia. A limited amount of study of the Seal Island Pluton has been done previously, and hence its age and relationship to the mainly Devonian granitoid intrusions of mainland Nova Scotia are uncertain. However, it has been reported to consist of coarse-grained biotite granodiorite and monzogranite, gradational to muscovite-biotite monzogranite and syenogranite, and to be similar in texture and mineralogy to the South Mountain Batholith. Based on the presence of hornfels and metasandstone xenoliths in the monzogranite and syenogranite, the pluton intruded the Meguma Group.

This study aims to examine through petrographic and geochemical analysis the origin, tectonic setting, and emplacement of the Seal Island Pluton and interpret its relationship to other granitoid intrusions of southwestern Nova Scotia. The pluton was mapped and sampled during two days in the summer of 2004 on all the islands on which it outcrops. Preliminary results suggest that it consists mainly of biotite monzogranite. Weak foliation resulting from preferred orientation of biotite ± muscovite was observed in most outcrops, generally trending approximately north-south. Steep shear zones (<50 cm wide) occur throughout the pluton but are more abundant along the western side of Seal Island. These zones trend north to north-northeast and have subhorizontal mineral lineations, locally well developed c-s fabrics, and asymmetric porphyoclasts which exhibit a dextral sense of shear. The shearing may be related to the offshore extension of the major Chebogue Point Shear Zone southeast of Yarmouth.

A distinctive characteristic of the pluton is the presence of tourmaline layers and patches, in places composing up to almost 2% of the rock. Pegmatite dykes and pods occur throughout the pluton, and rare mafic dykes (<1.5 m wide) occur on Seal and Mud islands. The two dykes on Seal Island are highly deformed as they occur in north-trending shear zones. The dykes are likely syn- to late intrusive within the granite, based on observed comingling textures. Magnetic susceptibility was measured in the field at all outcrops, and susceptibility values are low in granite and pegmatite, ranging from 0.00 to 0.35, but mainly between 007 to 0.15 $x10^{-3}$ SI units. Mafic dykes have somewhat higher values (0.53-0.75).

Samples from the Seal Island Pluton are being analyzed for major and trace elements, and petrographic studies are in progress. Mineral analyses will be done by electron microprobe. Preliminary work suggests that the pluton differs in appearance from the Wedgeport, Shelburne, and Barrington Passage plutons, and is unlikely to directly link to any of these nearby "peripheral plutons" of the South Mountain Batholith.

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Mine Permitting 101: How to get a Mine Permitted in Nova Scotia

P. Oram[1]

Taking a mineral deposit through the permitting process is a complex sequence of events that sometimes seem to have neither rhyme nor reason. The process can vary greatly in complexity and time frame, depending on site conditions and the interplay between the proponent and the local community. This talk outlines the current permitting framework in Nova Scotia and provides information on approaches that have had success. The talk discusses the various phases of a mine permitting project, from grassroots exploration through to production. The talk will include a discussion of First Nations involvement in the baseline data collection phase and permitting phase, and provides a blueprint for future First Nations involvement, with an emphasis on the structure of the project team and the factors affecting a positive proponent/First Nations approach.

The talk also discusses 'pre-development' studies and the benefits to the project in terms of permitting time lines and relationship building with stakeholders. In many cases the completion of these 'pre-development' activities can assist in reducing overall costs for mine development by moving the completion time frame for these activities closer to the exploration phase than the development phase. Completion of the studies during advanced exploration, instead of during pre-feasibility or feasibility, was cited by community groups and regulators (provincial and federal) as a major reason for a decreased time period from initiating permitting.

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Examination of Mafic and Felsic Intrusions in Carboniferous Rocks of Southern Pictou County and Eastern Colchester County

G. A. O'Reilly

The area of lowlands between the eastern end of the Cobequid Mountains and the Antigonish Highlands is underlain predominantly by rocks of Carboniferous age. Major faults related to the Cobequid-Chedabucto Fault Zone (CCFZ) deform these rocks, as well as the older, lower Paleozoic crystalline basement rocks. Several sites along the CCFZ are currently undergoing exploration for iron oxide-copper-gold (IOCG) deposits, which is the result of a recent recognition that deposits of IOCG affinity are present along the CCFZ, and that the geological setting of this major transform fault system contains many of the features indicative of an IOCG terrain. Over the past field season, geological mapping as part of the federal-provincial Targeted Geoscience Initiative, Phase 2 (TGI-2) was initiated to further define these features, in particular the occurrence, age and nature of mafic and felsic intrusive rocks and how they relate to IOCG mineralization.

Fletcher (1902 a, b), in geology maps of southern Pictou County and eastern Colchester County, indicated numerous small mafic and felsic intrusions occurring within the Carboniferous rocks. Fletcher (1893) made frequent mention that at least some of these intrusions intrude their enclosing host rocks as opposed to simply being faulted into place along faults related to the CCFZ. During the past field season, many of these locations were visited and examined. At some of the sites (Limerock and John McDonald Brook), it was found that highly bleached and altered sandstone units were mistakenly identified as felsite. However, there are many sites at which mafic and felsic intrusive rocks are present. Field examinations have shown that some of these plutons were emplaced along fault structures and have had their contact relations obliterated or complicated by post-emplacement fault movements (e.g. Mt. Thom, Lorne, Lorne Station). At some sites, however, intrusive relations are present that indicate the plutons actually intruded their enclosing sediments (e.g. Moiche Hill, Centredale, Marshdale, Salmon River, Valley and Sunnybrae). The observed field relations indicate mafic intrusions definitely intrude the Carboniferous sediments, but the age of the felsic intrusions is not so clear. Wherever found, the small felsic intrusions occur within well developed fault zones where their original contact relations have been overprinted by subsequent fault movements.

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Aggregate Program Activities in 2004

G. Prime

The primary focus of the aggregate program in 2004 is the completion of a report on bedrock aggregate opportunities near the Metro Halifax market. This study was initiated because of aggregate supply concerns associated with the Greater Halifax area. Although the industry is capable of meeting current market demands, the future is less certain. The primary concern is the urban sprawl taking place on the fringe of Metro. Over the last few decades residential and industrial developments have encroached on the undeveloped land where aggregate resource potential exists. This has had the effect of rendering the land inaccessible for resource use. Compounding the problem are municipal bylaws and regulatory legislation which have become increasingly restrictive regarding the placement and operation of quarries. Although these regulations are necessary, they are having a major impact on resource accessibility. The permitting of new quarries in the area has commonly faced strong resistance from area residents who don't want this type of heavy industry near their communities. Attempts to permit new quarries near Metro in recent years have largely been unsuccessful.

Recent economic prosperity has seen the acceleration of resource land sterilization and consumption of the aggregate reserves in existing quarries. Unless new deposits can be activated, aggregate reserves will shrink until there is no longer a local resource to access. It may take decades, but the loss of the resource is inevitable. Aggregate needs will then have to met from outside the area. This would have serious implications for the community and the environment. Obtaining the more than 3 million tonnes of stone used in the area annually from distant sources would significantly increase the cost of these bulk materials for the consumer, public works agencies and the tax payer. Longer truck hauls would also increase fossil fuel consumption, equipment wear and air emissions per tonne of stone delivered to the construction site. In an attempt to mitigate this disturbing resource trend, NSDNR has been conducting research to see if there are aggregate deposits near Metro which may offer development opportunities in the future. The results of the field work and sampling program concluded that there are areas with promising resource potential. The report and maps will be released shortly.

Another priority for the aggregate program was the completion of field work on the Annapolis Valley Project. This ongoing research has been looking at the bedrock and surficial aggregate potential in Hants, Kings, Annapolis, Digby and Yarmouth counties. During the months of September and October, previously undocumented sites scattered throughout the region were examined and recorded. Other work conducted during the summer was the compilation of geological maps in a digital format by Paul Barker and the GIS Section at DNR. Work remaining on the project includes the entry of digital point data, laboratory analysis of samples, and air photo interpretation. Products from this research will consist of resource maps, a report, and a digital database identifying the aggregate resource in the region. A summary of the preliminary results is anticipated to be released next year.

Finally, an ongoing joint project with DNR geologist Chris White is continuing this fall. The purpose of this research is to look at aggregate in the province from an in-depth scientific approach. It is hoped that a comparison of geoscientific data with engineering test results will lead to a better understanding of the qualities that affect aggregate performance. The long-term objective of this work is to use this information as a predictive tool in the identification of high-quality construction aggregate. This could be useful in the exploration for new deposits, as well as helping quarry operators gain a better understanding of their deposits with product quality control in mind. The pending work for this year (to be done in the late fall if the weather permits) will be the examination and sampling of granite bedrock sites and quarries in western Nova Scotia.

Basin Brine Expulsion, Solution Front, to Iron Oxide-Copper-Gold Models: The Carboniferous Cu-Ag-Au-Co-Pb-Zn Connection

R. J. Ryan

Over the last 30 years there have been numerous metallogenic models proposed for Carboniferous mineral deposits in the Maritimes Basin of Atlantic Canada. The models have included Mississippi Valley type Pb-Zn, Irish Fault-related Pb-Zn, Supergene Redbed Cu, Kuperschiefer Cu-Pb-Zn, Sabkha-related Pb-Zn, Solution Front Cu-Ag-U, Laisvall Sandstone Pb, Volcanic Exhalative Pb-Zn, Syngenetic Barite-Celestite, Manto Type Celestite-Barite, Karstification Solution-trench Pb-Zn-Celestite- Barite, Diagenetic Replacement Barite, Basin Brine Expulsion Pb-Zn-Cu-Ag-Ba, Iron Oxide-Copper-Gold (IOCG), and many others. The numerous models would seem to indicate a complex and varied metallogenic history for the region that would preclude any synthesis. Enormous leaps in our understanding of tectonics, structural geology, and thermal basin evolution of the region have provided an opportunity for a re-examination of the context for the various metallogenic models proposed. The basin brine expulsion model proposed for carbonate-hosted Pb-Zn deposits in Nova Scotia was the first attempt to model mineral deposit distribution and mineralization on a basin-wide scale. The model assumed that basin brines were expelled from the central parts of the Maritimes Basin by simple loading as a result of sedimentation. This simplistic model had many limitations, such as its failure to recognize structural barriers or the role of syndepositional tectonism. This model was modified to accomodate tectonic fluid pumping within the basin, as evidence of these events were documented by Carboniferous mapping projects. Regional thermochronological studies of the basin provided insights into the timing of maximum burial of the strata, and the subsequent exhumation of the basin, suggesting that localized brine expulsion was possible and that the timing of maximum burial corresponded to many of the mineralizing events dated by other methods. Recognition of paleo-weathered surfaces of varying ages in the Atlantic region, combined with the exhumation history derived from fission track studies, have provided constraints on the timing of oxidizing groundwater-related mineral deposits in the region. The distribution of mineral deposits in the Maritimes Basin has a strong correlation to major basin structures, including the Cobequid-Chedabucto Fault Zone as well as basin margin faults.

Recognition of Carboniferous intrusive and extrusive bimodal igneous rocks associated with major sutures, shears and faults within the basin, combined with numerous sulphide-poor iron-rich mineral occurrences and deposits, has further modified the overall metallogenic model. It should be noted that there may be a genetic link between the copper-cobalt occurrences along the Cobequid-Chedabucto Fault Zone and the cobalt-rich diagenetic pyrites and copper ores of the Cumberland Basin. It is possible, therefore, to modify the basin brine expulsion model to accommodate most of the deposit types in the Maritimes Basin by recognizing temporal and spatial relationships.

Gem Quality Citrine and Smoky Quartz, Annapolis County, Nova Scotia

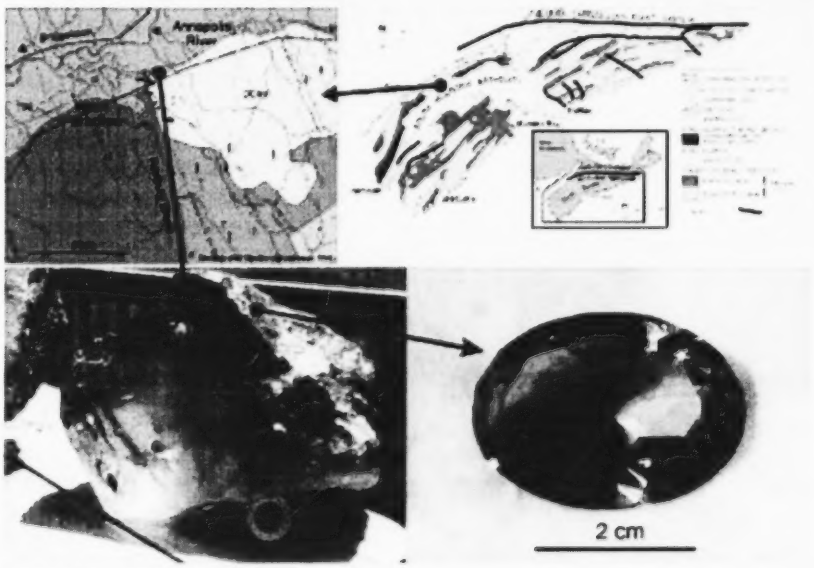
P. K. Smith and P. H. von Bitter[1]

Gem quality, clear citrine and smoky quartz crystals up to 50 kg in weight and 33 cm in diameter were first recorded almost 200 years ago from the vicinities of Paradise River, Bridgetown and Lawrencetown. Early publications speculated that a large quantity of crystals could be found in these areas.

These gem quality quartz crystals have complex intergrowths of yellow to black phases and exhibit a complex growth history. Their exterior 'skin' of milky quartz, often capped by jasper, generally hides their inner clarity and beauty. One specific area in which gem quality quartz occurs is immediately east of Roxbury Brook at West Paradise. There, gem quality quartz is concentrated over the contact between the Devonian Inglisville Leucomonzonite and the Triassic Wolfville Formation. The feldspar and quartz-rich Wolfville sandstone is largely derived from the breakdown of these Devonian granitoids. Associated China clay and a pre-glacial weathering horizon are also present at, and near, this location, respectively.

Limited field work in this area suggests that: (1) a single, large (15 cm), gem quality smoky quartz crystal in medium-grained monzogranite confirms a bedrock source, (2) quartz-rich segregations with minor tourmaline and feldspar are common throughout parts of the Inglisville Leucomonzogranite, and (3) gem quality clear citrine and smoky quartz crystals, associated with milky quartz and jasper 'caps', are moderately common in the soil horizon on the north-facing slope underlain by the Inglisville Leucomonzogranite.

We infer that these gem quality crystals, and associated China clay, were freed from the Inglisville Leucomonzogranite and were transported and concentrated down-slope to their present locations during a pre-Triassic and/or pre-glacial weathering event(s). Future research will include additional field work to locate potential *in situ* sources of gem quality quartz, as well as an evaluation of the trace element geochemistry of these crystals.



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Glacial Lakes in Nova Scotia and their Economic Legacy of Sand and Clay

R. R. Stea

At the end of the last ice age a retreating glacier in northern Nova Scotia and the Gulf of St. Lawrence covered drainage outlets to the north, creating large glacial lakes in the lowland basins to the south and east. Glacial Lake Shubenacadie, for example, covered much of the Shubenacadie and Musquodoboit valleys to a maximum depth of ~30 m, defined by the elevation of rock sills in alternate drainage routes to the Atlantic Ocean. Many of the former lake basins are covered by clay deposits that are unusually fine-grained and massive, often lacking graded beds with coarse silt and sand that characterize glacial lake sediments (varves), and having a low percentage of dropstones. This is an indication that the glaciers were far removed from the basins, damming rather narrow outlets to the ocean. Sand deposits formed on the margins of the glacial lakes as deltas or subaqueous outwash, where glacier meltwater streams had ingress to the lake or as shoreface sand formed by wind and wave reworking of till deposits on the former shorelines. Recognition of the vast extent of these glacial lakes opens up many new areas with the potential for economic deposits of clay and sand.

Clay deposits at Lantz, Nova Scotia, are presently being used to manufacture pottery and brick, and similar deposits in the Annapolis Valley and southeast Cape Breton Island were mined at the turn of the 20th Century. Use of clay as a ceramic material for pottery and structural products depends on a range of properties unique for each industry. A common denominator for industrial uses is a large-volume source of moderately uniform clay that has a low shrinkage/swelling percentage, consistent firing colour, relatively low firing temperature, and good strength after firing. Typical Nova Scotia massive clays are of the earthenware type, and meet the requirements of many low temperature ceramic products. They have low firing temperature, excellent strength, low boil absorption and low alkali content, and are suitable for structural products (brick and tile) provided they are mixed with a suitable filler to reduce the dry shrinkage, lamination tendency and demand for water of extrusion. In some lake basins siltier facies, as yet untested, may be utilized without the addition of filler.

Clay, because of its fine-grained, plastic nature, has significant application as natural impermeable seals for civil engineering/geotechnical projects such as waste facility liners, cover seals, and sewage lagoon liners. Current environmental standards demand high impermeability and long-term stability for the liner material. Preliminary data indicate that some of the massive clay deposits have potential for use as a landfill bottom liner system (or cover material) due to low permeability and high plasticity.

Neglected resources of these glacial lakes are the extensive sand deposits associated with them, often hidden under a veneer of clay. The sand deposits can have a wide variety of uses including concrete and asphalt manufacture, sand blends for topsoil and compost, landscaping and filtration for disposal fields.

Can Glacial Till be Mined for Gold in Nova Scotia?

R. R. Stea, R. F. Mills, P. K. Smith and T. A. Goodwin

Bouldery deposits of glacial till cover lode gold deposits on the Meguma Terrane. During the last glaciation, local ice caps left a trail of eroded and transported gold-rich debris that led to the first documented gold discovery in the mid-1800s. Since that time till deposits have been used as an effective prospecting tool for the lode deposits, but are generally considered to be a hindrance in the development of mines.

Our interest in the gold potential of glacial till was piqued by the discovery of an adit in a drumlin-like hill at Tangier, Nova Scotia (see Mills, this volume, p. 19). The adit is located ~0.5 km southeast of the main Tangier mining district. The ~60 m long tunnel was dug into a local stony till deposit (Beaver River Till) at the contact with a lower reddish, clay-rich till (Lawrencetown Till). Panning of the upper till in the adit revealed abundant fine gold and some mm size nuggets. Further exploratory panning revealed gold in the Beaver River Till across the entire face (~125 m) of the till outcrop. The discovery of gold in the till suggests that the adit was a form of placer mine, which may have predated the Tangier gold discovery in 1861, as there is no known record of this adit. The Annual Report of Mines (1867) documents placer gold workings in the vicinity of Tangier, which included the discovery of a 27 oz. nugget. The locations of these placer workings are uncertain and may have been in the vicinity of Copper Lake. A newspaper report in the 1880s describes the mining of glacial till at the Moose River Gold Mine with yields of 0.1 oz./ton.

In order to assess the economic viability of gold in till, the Quaternary section near the Tangier adit was sampled in five discreet vertical sections, using an excavator. All the sections had a mature soil horizon, ensuring that the deposits were *in situ*. Twenty-eight 10 kg samples were obtained from the five sections. These samples will be evaluated for free gold content and gold content in the < 230 mesh matrix fraction. In addition, the coarse gold content of the sand and granule fractions of the till will be assessed.

The till section is approximately 1 km down-ice of the vein swarms that constitute the Tangier Gold District, and there is no evidence of veins in the vicinity of the section. If high grades of gold in the section can be verified, the potential of mining till will be greatly enhanced. The potential volume of gold-rich till in this area could be substantial considering the thickness of the gold-bearing section (~5 m), and the minimum length of the dispersal train (~0.5 km), which would theoretically become more enriched closer to the lode source.

High Resolution LIDAR Survey of the North Mountain Basalt

T. Webster[1]

A high resolution LIDAR survey has been conducted over the Annapolis Valley, Nova Scotia. The LIDAR (Light Detection and Ranging) data consist of elevation points spaced at 3 m on the ground in open areas, and has a vertical accuracy of 15 cm. The LIDAR data have been used to build a "bald earth" digital elevation model (DEM). Watersheds feeding the streams of the North Mountain Basalt (NMB) into the Bay of Fundy have been automatically delineated from the LIDAR-derived DEM. Bedrock incision depths have been calculated based on the stream elevation long profiles and the current surface profiles of the drainage divides. The DEM has also been used to map the extent of the three flow units of the NMB. The upper flow unit (UFU) outcrops along the shore and consists of 1-2 flows, is massive and columnar jointed. The UFU overlies the middle flow unit (MFU), which consists of multiple thin flows that are highly vesicular and amygdaloidal. The MFU overlies the lower flow unit (LFU) which forms the cuesta of the valley and consists of a thick massive single flow. The MFU is less resistant to erosion and as a result has a distinct topographic signature on the LIDAR. A new geological map of the three flow units has been constructed based on the topographic expression of the flow units and constrained by outcrop locations in the field. The flow unit map will be used to assess the stream-long profiles in order to evaluate nick points and other morphologies associated with the streams incision processes. In addition to the flow units, several ring structures have been identified in the LFU. These ring structures are chemically similar to the main flow; however, the rims and centers of the craters, have an abundance of glassy material. These structures are interpreted to represent 'sag flow out structures' and are a result of the interaction of water and lava. The model for these structures involves the eruption of lava into a terrestrial environment, followed by a raise in the water table prior to complete crystallization of the lava within the flow. The interaction of the water and lava caused phreatic explosions through the crust of the lava causing radial fractures. These fractures were then replaced with dikes of the molten lava forming radial patterns. Subsequent erosion has removed the less resistant material and left the glassy dike material around the edge and centers, forming these ring structures.

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Significance of the High Head Member, Southwestern Nova Scotia: New Fossil Evidence for a Late Precambrian(?) to Early Cambrian Age for the Lower Goldenville Formation

C. E. White, M. K. Gingras[1] and J. W. F. Waldron[1]

The oldest unit in southwestern Nova Scotia, the Goldenville Formation, is generally considered to be a monotonous sequence of undividable, thick metasandstone beds. However, based on recent field work related to the Southwest Nova Mapping Project, combined with high-resolution aeromagnetic data, a thick interval of metasiltstone (High Head member) containing abundant trace fossils was recognized as a distinct, regionally mappable unit.

A complete section of the member is exposed along the coast in the High Head area north of Yarmouth. It consists of 780 m of grey to grey-green, well laminated, magnetite-rich, fine-grained metasiltstone. A series of 7-8 thin (30 cm to 1 m wide) light grey metasandstone beds separated by thin (<25 cm wide) metasiltstone beds is present in the middle of the section. The metasandstone beds are typically coarse-grained to conglomeratic at the base, and fine upwards into laminated to cross-bedded fine-grained metasandstone. Also in the area of the metasandstone beds are two thin (1 m wide) basaltic sills. The lower sill displays peperite-like structures along its lower contact with the metasiltstone, suggesting that it intruded unconsolidated wet sediments. Two thin (<1 m wide), well cleaved mafic dykes occur farther down section. Other than the fine laminations and rare ripple marks and cross-bedding, the High Head member lacks sedimentary structures.

The base of this member is gradational over several metres with an underlying unit of grey massive metasandstone (1-3 m wide) interbedded with minor metasiltstone and rare slate. The upper contact is also gradational and marked by the presence of several thin (<10 cm) metasandstone beds that increase in thickness (to >1 m) and abundance up section into the overlying unit. Overall, the unit strikes northeast and dips steeply (~60°) to the southeast and is located on the southeast limb of the regional Black Point anticline. A steep (~80°) northeast-trending and southeast-dipping, weak to moderately developed cleavage is present that results in a shallow southwest-plunging intersection lineation. Kink bands are common throughout the section. Deformed trace fossils in the metasiltstone indicate a strain ratio in the bedding surfaces of approximately 1:2.

The High Head member appears to be barren of shelly fossils but contains abundant trace fossils. The ichnofauna includes a wide variety of ichnotaxa, such as *Chondrites*, *Helminthopsis*, *Oldhamia*, *Phoebichnus*, *Phycodes*(?), *Planolites*, *Psammichnites*, *Spiroraphe*, *Taenidium* and an unidentified *agrichnia*-style trace. No arthropod trackways were recognized. The only direct evidence of the age of the High Head member is the presence of the index trace fossil *Oldhamia*. *Oldhamia* is a characteristic ichnofossil of fine-grained, deep-water siliciclastic sequences of Early to early Middle Cambrian age. This occurrence of *Oldhamia* is the first reported in Nova Scotia and its presence suggests that the age of the lower part of the Goldenville Formation, below the *Oldhamia* occurrence, may extend into the Precambrian.

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The Last 550 Million Years: A Geological History of Southwestern Nova Scotia

C. E. White and R. J. Horne

Southwestern Nova Scotia is underlain mainly by metamorphic rocks of the Cambrian to Ordovician Goldenville and Halifax formations (together termed the Meguma Group), overlain by the Silurian White Rock Formation and the Early Devonian Torbrook Formation. These rocks were deformed and metamorphosed during the Devonian Acadian Orogeny and intruded by several Devonian granitic plutons. The Cambrian to Early Devonian metamorphic sequence and Devonian granitic rocks are the characteristic units of the Meguma Terrane. Mesozoic sedimentary and volcanic rocks unconformably overlie the older rocks on their northwestern margin.

Recent 1:10 000 scale bedrock mapping in the Digby-Yarmouth-Liverpool area, combined with structural and metamorphic analysis, paleontology and geochronology, have placed new constraints on the tectonic significance and timing of geological events in this part of the Meguma Terrane. The oldest unit in the area, the Goldenville Formation, has been subdivided into three members. The High Head Member contains numerous trace fossils including *Oldhamia*, an early Cambrian deep-water ichnofossil. The presence of *Oldhamia* suggests that the lower part of the Goldenville Formation (below the fossiliferous interval) may extend into the Precambrian. The Halifax Formation also has been divided into three new members, from oldest to youngest the Bloomfield, Acacia Brook/Cunard and Bear River/Sissiboo members, which broadly correlate with subdivisions established elsewhere in the Meguma Terrane. The upper parts of the Bear River Member locally contain *Rhabdinopora flabelliformis*, an Early Ordovician (earliest Tremadoc) graptolite. The presence of this fossil suggests that the underlying members of the Halifax Formation may be Cambrian in age. The Meguma Group is interpreted to have originated as a continental rise prism adjacent to the margin of Gondwana, perhaps in the vicinity of present-day Morocco.

Fossils in the overlying White Rock Formation indicate a Silurian age for most, if not all, of the formation. However, U-Pb dating of volcanic rocks indicates that the base of the formation may extend only into the latest Ordovician. Hence a considerable time gap (ca. 30-40 million years) may exist between the top of the Halifax Formation and the base of the White Rock Formation. The contact between the Early Devonian, fossil-rich Torbrook Formation and the underlying White Rock Formation is gradational. All of these units are intruded by several suites of syn- to post-depositional mafic sills. New geochemical studies suggest that volcanic rocks in the White Rock Formation have within-plate chemical affinity and may have formed when the Meguma Terrane rifted from Gondwanaland.

During the Acadian Orogeny, the Meguma Group and White Rock and Torbrook formations, together with the mafic sills, were folded and metamorphosed. In the Digby-Yarmouth-Liverpool area regional metamorphism ranges from greenschist facies in the north to amphibolite facies in the south. Numerous Late Devonian granitoid rocks, some with significant tin mineralization (e.g. Davis Lake Pluton), truncate regional fold structures but are interpreted to be late syn-tectonic. An exception is the post-tectonic Wedgeport Pluton that has yielded an early Carboniferous U-Pb crystallization age, similar in age to the Brazil Lake Li-Ta-Nb-Sn-bearing pegmatite occurrences. Middle Carboniferous (Alleghanian) shear zones are recognized in the Yarmouth area, and may be responsible for local gold mineralization. The Tobeatic shear zone, which hosts the Black Bull quartz and kaolin deposit, also may be, in part, Alleghanian in age.

In the early Carboniferous, much of the Meguma Terrane was being unroofed and shedding sedimentary detritus into adjacent basins. However, the southwestern part of the terrane remained buried and was not unroofed until the Middle Triassic, with deposition of the Mesozoic sedimentary and volcanic rocks along the northwestern margin of the area.

Preliminary Map of Bedrock Geology of the Area between Lockeport, Liverpool and Lake Rossignol, Shelburne and Queens Counties (NTS Map Areas 20P/10, 14, 15; and 21A/02 and 03)

C. E. White and T. A. Lawrence[1]

The South Shore Mapping Project was initiated in 2004 as a continuation of the Southwest Nova Mapping Project. The main objectives of this study are to: (1) produce a series of 1:50 000 scale geological bedrock maps of the Meguma Terrane in Shelburne, Queens and Lunenburg counties, (2) attempt a stratigraphic subdivision of the Meguma Group and (3) comment on the economic potential of the area.

Bedrock mapping (1:10 000 scale) related to this project focused in the area between Lockeport, Liverpool and Lake Rossignol in Shelburne and Queens counties (parts of NTS map areas 20P/10, 14, 15; and 21A/02 and 03). As on previous map areas to the southwest, the oldest units are the Cambrian to Early Ordovician Goldenville and Halifax formations of the Meguma Group. The two-part subdivision of the Goldenville Formation recognized in the previous map areas to the southwest is continued to the east into the present map area. The lower unit is thickly bedded, massive, metasandstone whereas the upper unit consists of interbedded massive to well laminated metasandstone with metasiltstone, minor slate and rare conglomerate. The top of the upper unit is marked by approximately 300 m of thinly interbedded (5-20 cm thick) metasandstone and biotite + andalusite ± staurolite ± cordierite schist. Elsewhere in the Goldenville Formation this unit has been termed the West Dublin Member. Calc-silicate nodules and beds are common throughout the formation. Burrowing trace fossils were observed in the lower unit but have not been assigned an age.

Above the West Dublin Member is approximately 100 m of a thinly bedded (1-10 cm) sequence of pink coticule layers, fine-grained metasandstone and biotite + andalusite ± staurolite ± cordierite schist. Elsewhere in the Meguma Group this unit has been termed the Moshers Island Member and interpreted to mark the base of the Halifax Formation; however, other that the presence of coticule layers this unit resembles more closely the underlying West Dublin Member of the Goldenville Formation. In sharp contact with the underlying Moshers Island Member are black, chiastolitic ± cordierite-bearing slates of the Cunard Member. Because of the abrupt lithological contrast we interpret the Cunard Member as the base of the Halifax Formation.

The ca. 373 Ma Port Mouton pluton (and associated satellite bodies) intruded rocks of the Meguma Group in the map area. It consist of medium-grained, locally foliated , biotite- and muscovite-bearing monzogranite to tonalite. Xenoliths of metasedimentary rocks are abundant. Pegmatite (containing tourmaline+garnet ±beryl), aplite and biotite-muscovite granite dykes are common. The granitic and pegmatitic rocks along the northern margin of the pluton are strongly deformed and display near vertical mineral lineations.

Units in the Meguma Group in the map area were deformed during the Devonian Acadian Orogeny into regional, north- to northeast-trending F1 folds with a well developed axial planar cleavage. Intersection lineations (L1) plunge gently to the north-northeast and south-southwest. Deformation was accompanied by greenschist (biotite)- to amphibolite (sillimanite)-facies metamorphism.

The Early Jurassic Shelburne Dyke is poorly exposed, but based on its distinctive aeromagnetic signature it extends through the map area.

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